TECHNICAL REPORT
NATICK/TR-82/043

EVALUATION OF T-RATIONS AND THE MOBILE FOOD SERVICE UNIT IN A FIELD EXERCISE: FT. DEVENS

BY
JOSEPH M. WALL
D. PAUL LEITCH
ELIZABETH COMSTOCK

UNITED STATES ARMY NATICK
RESEARCH & DEVELOPMENT LABORATORIES
NATICK, MASSACHUSETTS 01760

OPERATIONS RESEARCH/SYSTEMS ANALYSIS OFFICE

Approved for public release; distribution unlimited.

Citation of trade names in this report does not constitute an official indorsement or approval of the use of such items.

Destroy this report when no longer needed. Do not return it to the originator.

BLANK PAGES
IN THIS
DOCUMENT
WERE NOT
FILMED

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NATICK/TR-82/043	2. GOVT ACCESSION NO. AD-A124859	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EVALUATION OF T-RATIONS AND THE MOBILE FOOD SERVICE UNIT IN A FIELD EXERCISE: FT. DEVENS		5. TYPE OF REPORT & PERIOD COVERED Technical Report 6. PERFORMING ORG. REPORT NUMBER NATICK/TR-82/043
7. AUTHOR(s) Joseph M. Wall, D. Paul Leitch, and Elizabeth Comstock		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Natick Research and Development Laboratories Operations Research & Systems Analysis Office Natick, MA 01760		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 6.2, Project 1L162724AH99, Task AA, Work Units 032 (ORSAO), 088 (SATL)
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Natick Research and Development Laboratories Operations Research & Systems Analysis Office Natick, MA 01760		12. REPORT DATE September 1982 13. NUMBER OF PAGES 34
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Joint Service Requirement Identification: AMAFN 81-20 Advanced Concepts for Combat Food Service Systems; Appendix I, Evaluation of the Army Combat Field Feeding System

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

COMBAT FOOD SERVICE	MOBILE FOOD SERVICE UNIT	FOOD PACKAGING
FIELD FEEDING	MILITARY EQUIPMENT	
FOODSERVICE	MILITARY RATIONS	
T-RATIONS	TRAY PACKS	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Recognizing that the Army's present combat feeding system is ill-suited to the battlefield conditions anticipated in future conflicts, a new concept was developed. This report presents the results obtained in a field evaluation of two key elements of the proposed combat feeding concept, the Mobile Food Service Unit (MFSU) and the T-rations.

Three major conclusions are drawn from the evaluation: the MFSU can be efficiently operated by two personnel; the T-ration is an acceptable ration in the field; and heating, delivering, and serving the T-ration from the MFSU is a viable concept.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

PREFACE

This field evaluation was conducted as part of the Department of Defense (DoD) Food RDT&E Program under the Joint Service Requirement, AMAFN 81–20, "Advanced Concepts for Combat Food Service Systems", Appendix I, "Evaluation of the Army Combat Field Feeding System".

Staff members of the Science and Advanced Technology Laboratory, Behavioral Sciences Division, developed the consumer evaluation and cook interview protocols, collected the requisite data and provided the analytical results. The efforts of Dr. Herbert Meiselman, Dr. Lawrence Symington, Mrs. Barbara Bell, and Mr. Joseph Hunn are appreciated.

The successful performance of the prototype Mobile Food Service Units in this evaluation can be attributed in large measure to the overall guidance provided by Mr. Cornelius McKeown of the Aero-Mechanical Engineering Laboratory; Mr. David Corfield of the Food Engineering Laboratory, NLABS Project Manager for the Army Combat Field Feeding System; and especially the efforts of NLABS shop personnel, Mr. Paul Strain and Mr. Graham Symons.

Mr. Joseph Szczeblowski of the Food Engineering Laboratory also contributed to this effort by assuring that sufficient quantities of Tray Pack items were available for the evaluation.

Special recognition is accorded to Dr. Robert Byrne, Chief, Operations Research and Systems Analysis Office, for his support and interest in the evaluation effort. Other members of his office who made contributions are Mr. James Ovelman, Mr. Michael Ostrowsky, and Mr. George Turk.

Members of the US Army 39th Engineering Battalion, Captain Michael Lee, Battalion S–4, and LT Michael Crowley, Food Service Officer, coordinated the evaluation planning and provided on-site assistance, which required effort far beyond their normal responsibilities during a field exercise.

Special appreciation is extended to Miss Deborah Brooke who has provided excellent secretarial assistance to this project.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EVALUATION OF T–RATIONS AND THE MOBILE FOOD SERVICE UNIT IN A FIELD EXERCISE: FORT DEVENS

I. BACKGROUND

Recognizing that the present Army's combat feeding system is ill-suited to battlefield conditions anticipated in future conflicts, a new feeding concept has been developed.[1,2] In particular, the present combat feeding system is labor intensive and relatively immobile. The proposed system concept addresses these deficiencies while providing at least one hot meal per day to all combat soldiers. The new concept will provide this capability while reducing foodservice labor requirements by as much as 50 percent.

OBJECTIVES

The new system makes use of a new packaging technique that uses a flat can rather than the widely used round can. The package resembles a tray used with a steam table and, hence, is called the Tray Pack. The Tray Pack, when supplemented with items such as bread and beverage, comprises a T-ration meal. To deliver hot T-ration meals to troops in forward areas a mobile system has been devised and is identified as the Mobile Food Service Unit (MFSU).

This evaluation was conducted to determine if serving T-ration meals to troops in forward areas by the MFSU is a viable concept. Three specific issues are addressed: Can the MFSU be efficiently operated by two people? Are Tray Packs acceptable and suitable? Can the MFSU reliably heat on the move, and deliver T-ration MFSU to troops in forward areas?

This report presents the results obtained in an Army field training exercise of two key elements of the proposed system, the Tray Packs, and the MFSU serving areas in simulated combat conditions.

THE T–RATION

The Tray Pack component of the T-ration meal consists of a number of fully prepared, thermostabilized foods packed in containers configured as half-size steam table pans. Figure 1 shows examples of Tray Pack items. Lasagna, sliced roast beef, stuffed cabbage, stuffed peppers, salisbury steak, and chicken breasts are some of the other items currently available, in addition to the roast beef and pork shown. When other items such as bread, salad, and beverage are added to the menu to make a complete meal, the result is known as a T-ration meal.

[1] R. J. Byrne, A Proposed System for Army Combat Forces in the 1990's. Technical Report NATICK/TR–78/025. US Army Natick R&D Command, May 1978. (ADA 55091)

[2] R. J. Byrne, S. Baritz, R. V. Decareau, G. Hertweck, H. Kirejczyk and I. Nii, A Proposed Combat Food Service System Concept for the Army in 1990. Technical Report NATICK/TR–80/027. US Army Natick R&D Command, January 1980.

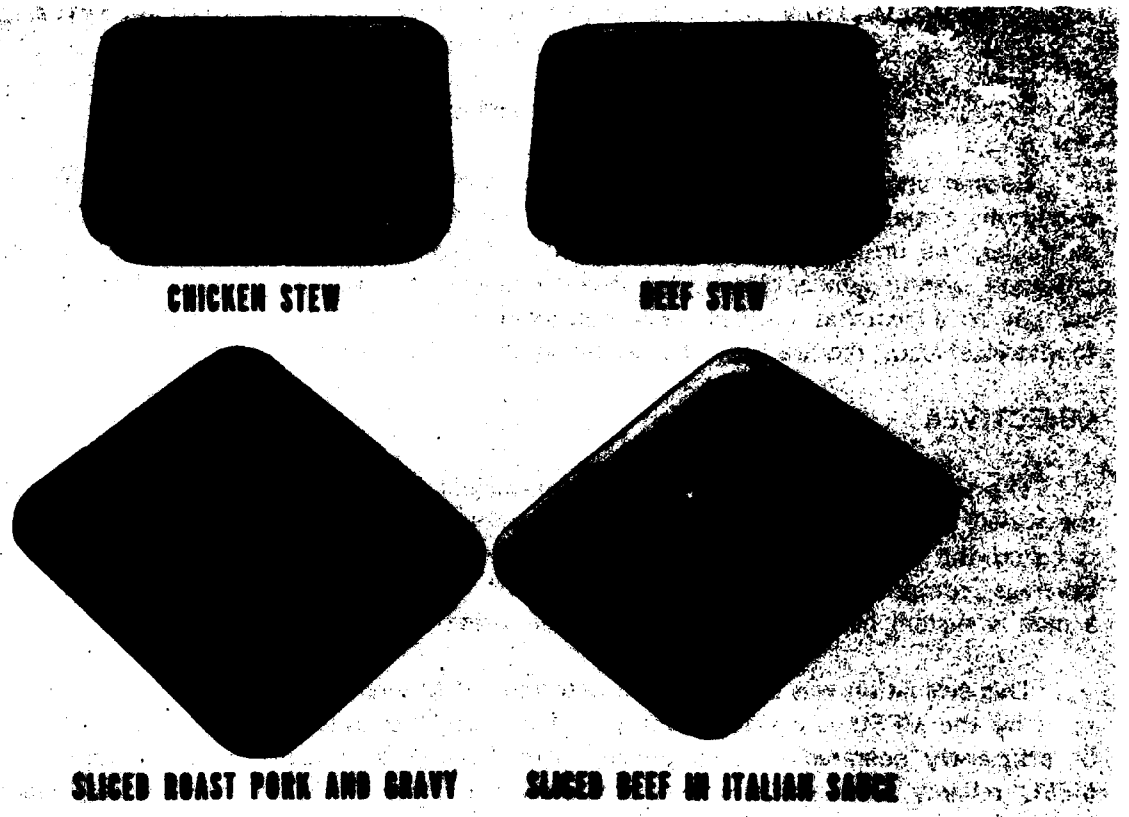

FIGURE 1. T-RATION ITEMS

The Tray Pack is a recent development in food packaging. It originated with a breakthrough in packaging, namely, the formation of a smooth-wall foil container of single serving size that could be hermetically sealed and thermally processed. Subsequent developments led to the introduction of a heavier duty, drawn multi-serving container that holds 12 to 24 servings in a half-size steam table unit. In volume, the Tray Pack is the same capacity as a No. 10 can, or 105 fluid ounces, and is designed to fit into a 12" x 20" steam table top opening. It is fabricated from precoated sheet steel by the drawn/redrawn method of manufacture. The tray lids are designed for double-seaming with specialized can closing machinery to form a positive hermetic seal. This double seam allows opening with standard can opening devices.

The flat shape of the container reduces thermal processing times. Studies show that food processed in Tray Pack containers takes less than 50 percent of the time to heat than the identical food packed in a No. 10 can. This translates into a savings in time and energy and also results in better food quality.

The Tray Pack is ideal for military field applications because it requires no refrigeration, stores easily and may be heated quickly and simply. Because Tray Packs require only to be heated prior to serving, labor requirements are significantly reduced. In addition, the container is disposable, thus reducing sanitation requirements.

THE MOBILE FOOD SERVICE UNIT

The Mobile Food Service Unit was designed to heat Tray Packs to serving temperature while stationary or on the move to forward locations where the T-ration is served to troops

in combat. The MFSU is required to have, among others, the following basic features or capabilities.[3]

- Heat T-rations packaged in a container approximately 10 x 12 x 3 inches from 25°F to 170°F in less than 30 minutes.
- It must be large enough so that sufficient rations may be heated to feed up to 120 people at one time.
- The equipment is to be skid-mounted and be suitable for use on a 2–1/2-ton truck or its replacement vehicle, on a 1–1/2-ton trailer, or on the ground.
- The unit is to be fully operational for meal service within ten minutes of arrival at the feeding site.
- The unit is to take no more than ten minutes to be fully prepared for movement to the next site.
- The unit is to have some means to protect the equipment and serving line from the environmental elements during transportation, food heating and serving operations.
- The unit is to be capable of transporting and storing 120 gallons of potable water and be able to dispense it through no less than four outlets for customer use.
- The equipment when trailer-mounted must be capable of being sling-loaded for airlift by rotary winged aircraft.

Figure 2 depicts the Mobile Food Service Unit as originally conceived. Although the prototype units actually tested differ in certain details, the main components remained as indicated in the figure.

These components are the diesel generator, the boiler, the Tray Pack heater unit, insulated Tray Pack holders, folding work tables and both hot and cold beverage storage/serving containers. Each of these components are portable for movement by no more than two persons.

[3] Letter of Agreement (LOA) for a Combat Field Feeding System, USATRADOC, ACN 44499, Feb 1981.

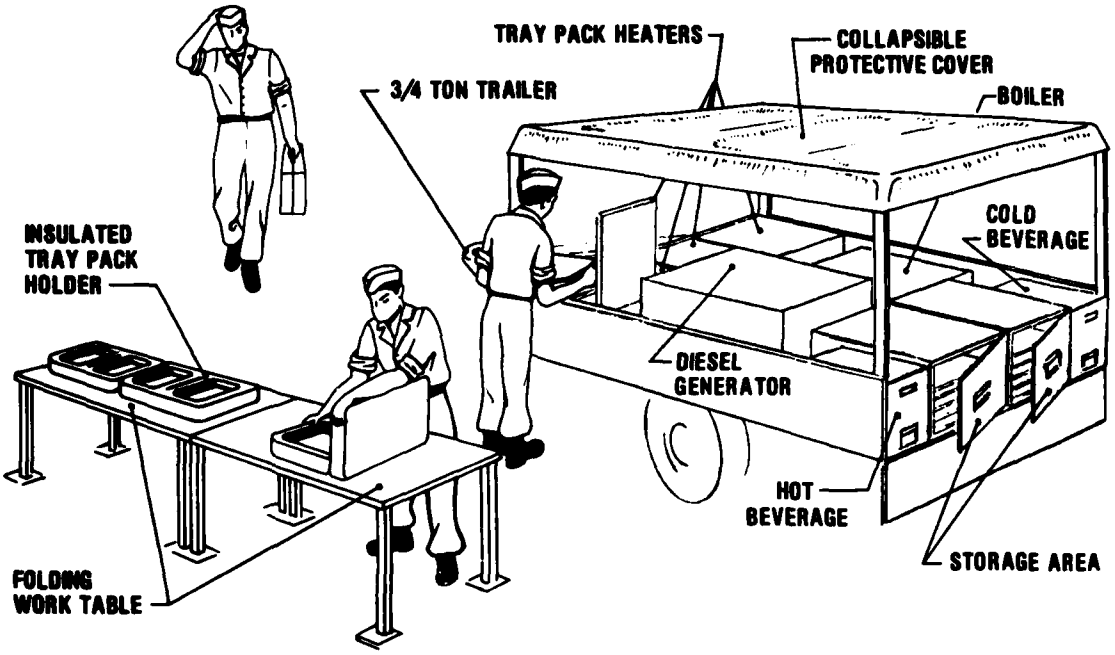

FIGURE 2. MOBILE FOOD SERVICE UNIT

NLABS investigated various concepts and configurations that the MFSU might take. The work resulted in the development of two experimental prototypes which have been designated Mark 2 and Mark 3. Photos of the two prototypes are shown in Figures 3 and 4, respectively. It is pointed out that the two prototypes were not designed to meet every detail required by the LOA but, rather, focused on the tasks of heating and serving T-rations under field conditions to determine if the concept is valid. For this concept evaluation, the Mark 2 components were mounted on a 1–1/2-ton trailer and were used to serve the troops in the forward areas, while the Mark 3 was mounted on a 3/4-ton trailer and was used to serve troops in the bivouac area.

The design of the Mark 2 and the Mark 3 differed in order to provide alternatives regarding space requirements, efficiency, and operational effectiveness as these three features are interrelated and will impact on the final design. The units are similar in that they both have a holding tank, called a converter, into which the T-rations are placed to be heated. Each has a heater, a water circulating pump, and a generator. The primary difference in equipment between the two models is that the Mark 2 heater is separate from the converter while the Mark 3 heater is an integral part of the converter.

The Mark 2 converter is somewhat shallow, contains about 40 gallons of water, and holds twenty Tray Packs. The Mark 2 operates with a 3-kWh generator. The Mark 3 prototype's converter is deeper and contains about 70 gallons of water. The Mark 3 has twelve racks which hold two Tray Packs each, one over the other, for a total capacity of twenty-four. This prototype operates with a 1.5-kWh generator.

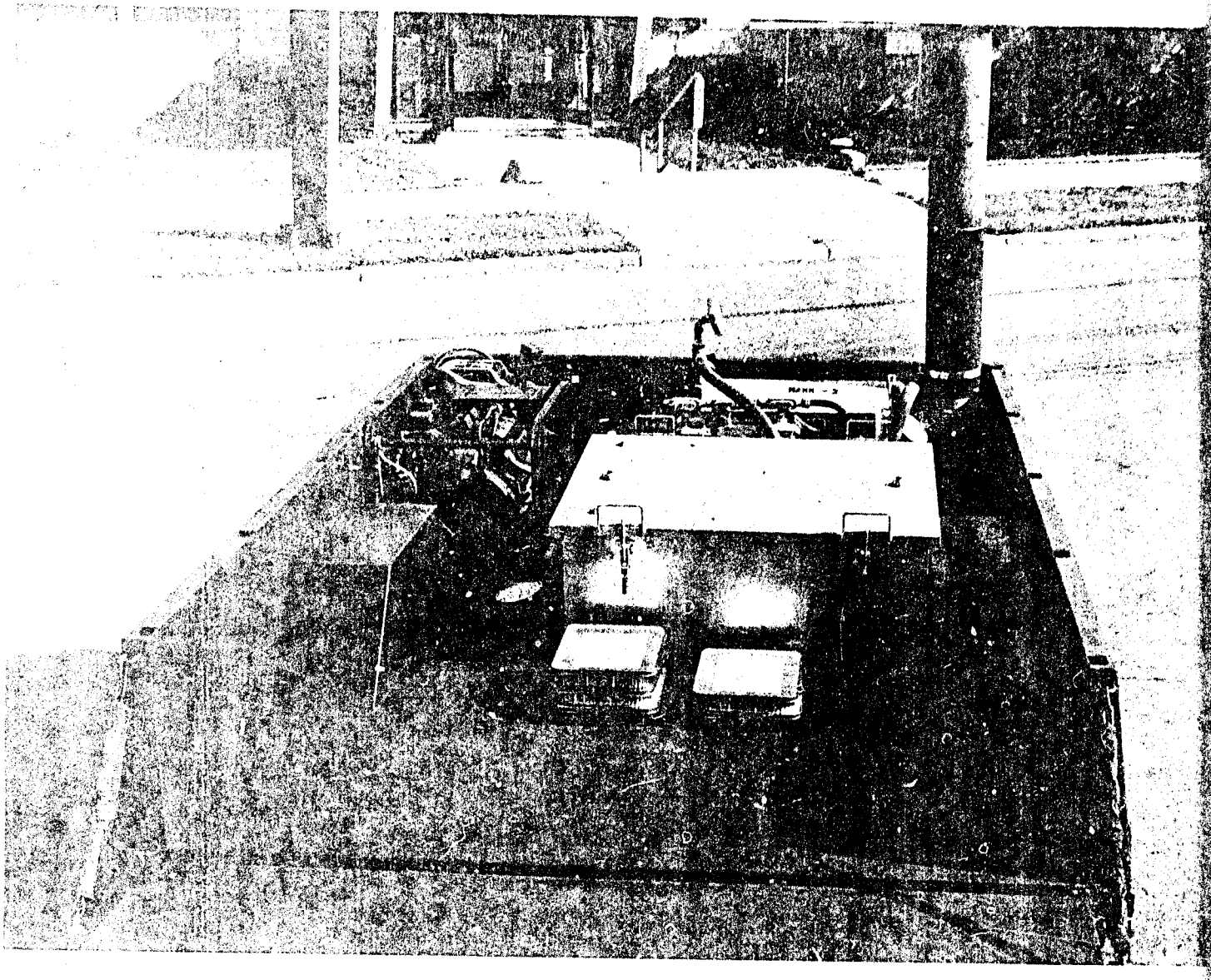

FIGURE 3. MARK 2 PROTOTYPE UNIT MOUNTED ON A 1–1/2 TON TRAILER

FIGURE 4. THE MARK 3 PROTOTYPE UNIT SKID MOUNTED

II. CONCEPT EVALUATION TEST METHODOLOGY

The concept evaluation was conducted from 30 March 1981 through 3 April 1981 at Fort Devens, MA with the 39th Engineer Battalion. The basic plan called for serving 175 troops with two MFSU's. One MFSU would serve approximately 100 troops in a bivouac area and one would serve 80 to 105 in the forward area. The forward areas were to simulate the forward line of troops (FLOT). The numbers to be served at each location in the forward areas ranged from 10 to 30 as shown in Table 1. These numbers were intended to be representative of those the MFSU would typically encounter, however, the numbers actually served were considerably higher because just three locations were available rather than the anticipated five. The numbers actually served will be found in Table 6.

Table 1

Planned Forward Areas and Number Of Troops to be Served

Area	No. to be Served
Water Point	10 – 15
Shower Unit	10 – 15
Combat Construction Platoon	25 – 30
Maintenance Platoon	25 – 30
Aircraft Unit	10 – 15

MENU

Meals were served in compartmented paper trays, using plastic knives, forks, and spoons. The noon meal consisted of T-rations, and the evening meal was comprised of A-rations. The menu served follows as Table 2.

Table 2

Menu

	Noon T-Ration	Evening A-Ration
Day 1	Chicken Breasts	Chili Mac/Veal
	Stewed Potatoes	Peas/Beets
	Green Beans	Sweet Potatoes
	Apple Dessert	Pie

Table 2 (cont'd)

	Noon T-Ration	Evening A-Ration
Day 2	Roast Beef	Ham/Swiss Steak
	Scalloped Potatoes	Green Beans
	Lima Beans	Potatoes
	Cherry Dessert	Pie
Day 3	Beef B–B–Q	Steak
	Baked Beans	Corn
	Whole Kernel Corn	Rice
	Apple Dessert	Pie

DATA COLLECTION PLAN

The data collection was focused on manpower requirements, customer acceptance of the meals served, and the operation of the MFSU components. Positive feedback on these three issues was deemed essential to any determination of concept viability. Thus, these major questions guided the planning effort:

1. Can the MFSU be operated by two foodservice personnel? (Two are considered to be the minimum required to meet setup and breakdown times and for the security and safety of the individuals).

2. Is the T-ration acceptable to Army troops in the field?

3. Will the prototype MFSU's perform to design levels in terms of time to heat rations, reliability?

MANPOWER

Four cooks were made available prior to the start of the exercise. The cooks received an overview on the total project and on the MFSU role in the total combat feeding system. They also received a detailed briefing on the T-ration concept and had an opportunity to open and sample heated Tray Packs. They were provided an information sheet, which is included as Appendix A. To simplify the manpower evaluation, it was determined to allow two cooks (the desired manning) to operate the MFSU, to note any deficiencies that may result, and to indicate the need for additional labor, if required.

T–RATION ACCEPTABILITY

To obtain food acceptance data, two separate groups were tracked as presented in the following figure (Figure 5).

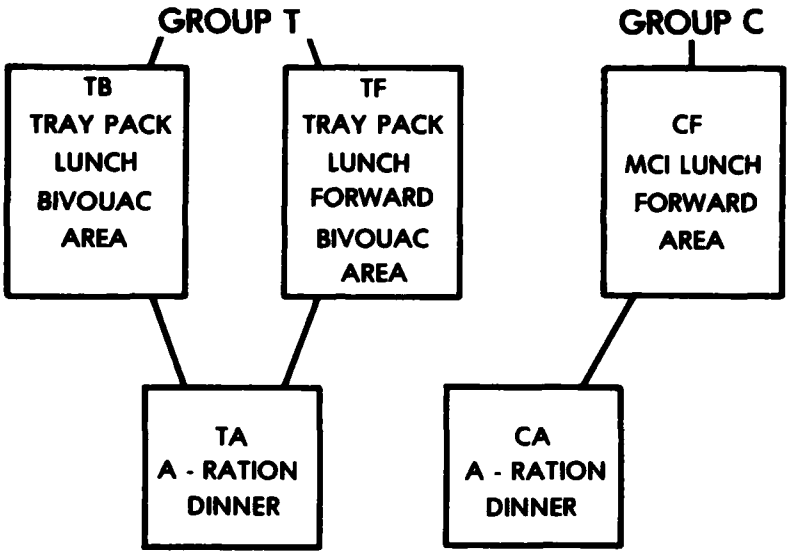

FIGURE 5. DESIGN OF FOOD ACCEPTANCE EVALUATIONS

Using the two separate groups the following comparisons were of interest:

1. TF vs CF: How do Tray Packs and MCI compare in forward sites?

2. TB vs TF: Are Tray Packs equally acceptable in bivouac and forward sites?

3. TB vs TA: How do Tray Packs and A-ration meals compare?

The food acceptance data were collected by interviewing customers at the feeding location as they finished their meal. A nine-point scale was used to rate food acceptability with "1" reflecting "dislike extremely" and "9" indicating "like extremely". The entire scale, with verbal anchors, is included in Appendix B. Customers were also asked to rate entree temperature and entree portion size. A seven-point scale was used for this purpose. The temperature question asked for a rating between much too cold ("1") and much too hot ("7"); on the portion size question, ratings were asked between much too small ("1") and much too big ("7"). The seven-point scales are also in Appendix B.

Customer opinions on food acceptability were collected in the following four conditions on each of the three days of the field exercise.

a. Tray Pack – Bivouac: Hot lunch meal served from the Mark 3 MFSU in the bivouac area of Headquarters Company.

b. Tray Pack – Forward: Hot lunch meal served from the Mark 2 MFSU in several forward areas to smaller groups of men from different companies on different days.

c. MCI: Individual rations eaten for lunch in forward areas, usually cold.

d. A-ration: Hot dinner meal prepared and served by cooks in general-purpose tents with field kitchen equipment in bivouac areas.

The procedures for obtaining customer food acceptance were the same in all conditions and are described in Appendix C, "Guidelines for Obtaining Food Acceptance Ratings".

In all four conditions, customers were interviewed where they ate – sitting on the ground, on a piece of equipment such as a truck, or in a tent. Food acceptance ratings were obtained at each meal for the entree, vegetable (or fruit for MCI which does not include vegetables), starch, dessert, and overall meal.

Portion data were collected to develop information on how many servings can be expected from Tray Packs in field conditions. The numbers of Tray Packs and disposable trays used were counted to determine how many were served and how much food was used. The data collection sheets used for forward and bivouac areas are in Appendix D.

MFSU COMPONENTS

The operation of the MFSU components were observed to ensure they would perform adequately in the field. Temperatures were recorded to verify that aspect of performance. Equipment was monitored during all operational periods to record any deviation that may reflect on its reliability or maintainability.

III. RESULTS AND DISCUSSION

CUSTOMER EVALUATIONS

Meal acceptability results obtained from customer evaluations of T and A-rations, as well as MCIs, consumed during the experiment are summarized in Table 3. Desserts are omitted because the diversity of types utilized made comparison across experimental conditions tenuous. In addition to the acceptability of these rations, ratings of food temperature and portion size are included. The individual ratings including desserts are summarized in Table 4.

Asked to rate the overall acceptability of the meal, customers' ratings of T-ration lunches are significantly higher than their evaluations of either the A-ration suppers or the MCI noon meals. The average ratings are 7.2, 5.4, and 6.2 for overall evaluations of the T, MCI, and A-ration meals, respectively. An analysis of variance on overall meal evaluations, summarized in Appendix E, indicates that, with a very high probability, T-rations would be preferred over A and MCI rations, were the conditions of this experiment repeated in the future.

The A-ration meal is generally thought to be the preferred meal because it is prepared from fresh ingredients. In this evaluation, that preference was not demonstrated. Actually, there were three aspects of this experiment which favored the A-ration meal evaluations.

First, the A-ration selections were high preference items. The results of the comparison are not therefore attributable to pairing popular or high preference T-ration against low

preference A-ration items; this is shown by the detailed breakdown by meals presented in Table 4. For example, the A-ration entrees were steak, ham, swiss steak, chili macaroni, and veal. The T-ration entrees were chicken breasts, roast beef and chicken. Yet the average acceptance ratings for the T-ration and A-ration entrees are 7.2 and 5.9, respectively.

Table 3

Food Acceptance Ratings Compared Across Four Combat Feeding Conditions*

	Tray Pack			
	Bivouac	Lunch Forward	MCI	Dinner A-Ration
Meal Overall	7.2	7.2	5.4	6.2
Entree	7.2	7.2	5.2	5.9
Starch	6.8	6.5	4.3	6.0
Vegetable	6.7	6.5	–	6.2
Temperature of Food	3.6	3.7	–	3.7
Portion Size	3.2	3.1	2.5	3.0

*Ratings of foods and the meal overall were made on a 9-point scale. Temperature and portion size were rated on 7-point scales.

Secondly, neither can the lower evaluations of A-ration entrees be attributed to a restricted menu which can sometimes cause customer criticism. The A-ration means contained two entrees per meal except on steak night. The T-ration meals offered but one choice per meal. Despite the greater choice of entrees available in the A-ration suppers, consumers reported significantly more favorable evaluations of T-ration meals.

A third factor, which at least theoretically favors higher acceptance for A over the T-ration meals, is that bread and salad were not offered with the T-ration meal. Customers of T-ration meals did not request salads but did report that they would like to see bread offered with the Tray Pack lunches.

Contradicting the trend for other meal components, the average rating for desserts is higher for A than for either T or MCI items. Table 4 presents these evaluations. Commercially produced, individually packaged, apple pies were provided for dessert in all three of the A-ration supper meals.

Compared to A and T-ration evaluations, the MCI averages are lower in every case whether customers were rating the meal overall or whether the average is based on the entree, starch, vegetable, and dessert components. One of the advantages of the proposed new combat feeding system is that it provides the capability to serve a T-ration meal where an MCI or its replacement, Meal Ready to Eat, may be the only practical options under the current system. The lower evaluations of the MCI in this experiment thus support the desirability of providing the more acceptable T-ration wherever possible.

Table 4

Consumer Evaluations of T, A and MCI Rations*

		31 March			1 April			2 April	
T-Ration		**Bivouac Mean**	**Forward Mean**		**Bivouac Mean**	**Forward Mean**		**Bivouac Mean**	**Forward Mean**
Entree (Tray Pack)	Chicken Breasts	7.2	7.8	Roast Beef	7.3	7.3	Chicken		6.4
							BBQ Beef	7.0	6.3
Vegetables	Green Beans	6.2	7.0	Lima Beans	6.8	5.1	Corn	7.1	6.2
Starch	Potatoes	6.7	6.6	Scalloped Potatoes/Ham	7.0	5.4	Baked Beans	6.6	6.8
Dessert	Apple Dessert	7.4	7.3	Cherry Dessert	7.3	6.9	Blueberry Dessert	6.6	6.4
Drink	Milk	6.3	7.3				Milk	7.2	
Overall Meal		7.3	7.9		7.5	6.6		6.8	6.6
Temperature		3.7	3.7		3.6	3.4		3.5	3.7
Portion Size		3.3	3.2		3.3	2.9		3.1	2.9
A-Rations:									
Entree	Chili Mac/Veal	6.2		Ham/Swiss Steak	5.2		Steak	6.7	
Vegetable(s)	Peas/Beets	6.3		Green Beans	5.4		Corn	6.7	
Starch	Sweet Potatoes	6.4		Potatoes	4.7		Rice	7.0	
Dessert	Pie	8.0		Pie	7.4		Pie	8.4	
Drink	Milk & Drink	7.8		Milk	6.8				
Salad		6.6					Salad	7.7	
Bread		6.6							
Overall Meal		6.2			5.3			7.3	
Temperature		3.6			3.3				
Portion Size		2.9			2.4			3.1	
MCI (C-Rations):									
Entree			5.9			4.9			4.8
Fruit			7.0			7.1			7.1
Starch			5.1			4.2			3.5
Dessert			5.8			4.4			4.9
Overall Meal			6.0			4.9			5.2
Portion Size			2.4			2.7			–

*With few exceptions, Mean ratings are derived from at least 15 customers interviewed during a given meal period.

Customer evaluations of the serving temperatures of the various food items as summarized in Table 3 show no significant difference between reports for Tray Packs in either the forward or bivouac area and A-ration dinners. In all three cases, the average ratings are within the area of the scale that reflects an evaluation just slightly on the cold side of "just right". This result was somewhat unexpected since equipment was available for maintaining the serving temperatures of Tray Packs and A-rations. The A-ration meal benefits from a field steam table, whereas the T-rations were served from insulated containers. The insulated containers have no means by which to maintain the water temperature other than that provided by the insulation. Hot water in these insulated containers was drawn from the Mobile Food Service Unit and was not capable of being kept as hot as the water in the steam table.

Consumer evaluations of the portion size are not significantly different from each other when either the T-ration or A-ration dinners are being evaluated. In each of these two cases, the ratings are again on the slightly low side of the "just right" position of the seven-point scale. Results in Table 3 show, however, that customers did perceive portion sizes in the MCI's as being smaller than they received in either the A or T-ration. As shown in Table 3, the evaluation of portion size in the MCI is based on only two meals as opposed to the other evaluations which are based on three meals. The difference is, however, statistically reliable, and it is appropriate to conclude that portion size for the MCI was less satisfactory to the soldier than were portion sizes of the A and T-rations in this field exercise.

MFSU PERFORMANCE

Two cooks were assigned to operate the MFSU during this experiment. Each day different cooks were assigned. The fact that they operated the system from just a briefing and very limited instruction speaks well for the simplicity of the MFSU. One day a cook reported for duty five minutes prior to serving time and with a short indoctrination performed his duties with no apparent difficulty.

The two personnel assigned each day were not always trained in foodservice. On two occasions a KP was the second person assigned. Yet they were quite able to operate the MFSU so that T-ration meals were delivered to the customer with acceptable results, as shown by the ratings in Table 3.

Overall, the MFSU's operated reliably and efficiently. No problems were encountered that had the potential to cause the delay or miss of a meal.

MFSU SETUP AND REPACK TIMES

One of the requirements of the LOA is that assigned personnel be capable of setting up the MFSU in ten minutes and be able to move in ten minutes following meal service. This capability is dependent on manpower and equipment working together. To determine if the prototype could meet this requirement, the time was recorded for travel from base camp to first feeding location, then to the next feeding location, then to the next feeding location, and so on. Setup time was recorded, as was the packup time. (The results are displayed in Table 5). Setup times ranged from 5 to 16 minutes with the average being 10.5 minutes.

Repack times ranged from 5 to 12 minutes with the average being 7.7 minutes. Given that these were the first prototype MFSU models, and that improvements designed to facilitate efficient setup procedures are yet to be made, ten minutes appears to be a very realistic and attainable requirement.

One example wherein improvements can be made is the serving table used with the MFSU. The prototype models utilized a standard 6' x 30" plywood field dining table carried as a separate item. A table specifically designed to function as an integral part of the MFSU might be more efficient.

Table 5

Distances Traveled and Times Required to Set Up, Serve, and Repack the MFSU

Day	Activity	Minutes to Complete Stop 1	Stop 2	Stop 3	Total No. of Miles
1	Travel	5	29	8	15
	Set Up	14	11	5	
	Serve	25	35	12	
	Repack	5	12	8	
2	Travel	22	22	13	16
	Set Up	16	10	10	
	Serve	6	5	4	
	Repack	9	7	5	
3	Travel	22	12		9
	Set Up	12	5	*	
	Serve	36	*	*	
	Repack	8	*	*	

*Data not collected.

SERVING AND TOTAL TIMES

While travel, setup, and repack times are relatively unaffected by the number of troops to be fed, serving times – and thus total trip times – are heavily dependent upon the number of customers served. The observed headcount ranged from 12 to 83; service time averaged 24 minutes the first day and 5 minutes on the second day, and total trip time improved on the second day, as reported in Table 6.

Table 6

Troops Subsisted, Service and Total Trip Times
Observed During the Experiment

Day 1:	Site	# Customers	Service Time	Total Trip Time
	1	24	25	2 hrs 49 min
	2	83	35	(15 Miles)
	3	14	12	
Day 2:				
	1	32	6	2 hrs 9 min
	2	17	5	(16 Miles)
	3	12	4	

The results indicate a notable improvement from the first to the second day of operations. The average serving rate increased from 1.7 customers per minute to 4.0. This accounts in large part for the decrease in total run time required from the first to the second day. Although the number of miles traveled each day was nearly constant, the run was accomplished in 40 minutes less time on Day 2. This is a relative reduction of 24 percent.

DISPOSABLES

The molded fiber compartmented paper tray available from GSA was used along with plastic knives, forks, and spoons. Cost data and item identification follow in Table 7.

Table 7

Cost and Identification Data on
Disposable Eating Ware

Item	NSN	Cost Each
Compartmented Paper Tray	7350–01–012–8787	$0.0418
Plastic Knife	7340–00–022–1316	0.0130
Plastic Fork	7340–00–022–1315	0.0130
Plastic Spoon	7340–00–022–1317	0.0120
Total Cost		$0.0798

The use of disposables along with the Tray Pack disposable pans eliminates the need for KP.

OTHER PROBLEMS AND SUGGESTED RESOLUTIONS

The Tray Packs that were used are commercially available and are routinely labeled with paper labels. When the product was placed in the hot water, the label became separated and clogged the filters in the circulating hoses. Tray Packs for field use should identify the contents of the container by stamping or stenciling the container rather than using paper labels.

The water in the converter was changed each day; however, even with this precaution, the water became rust colored. Aithough the discolored water is not inherently dangerous, the heat transfer coils should be made of stainless steel or copper to avoid discoloration of heating water.

The converters were not insulated and considerable heat loss was detected. The converter should be insulated.

As the MFSU passed over rough terrain, some water was spilled. Cover gaskets should be added to prevent spills.

The cooks did experience some difficulty in transferring the hot Tray Packs from the converter to the opener and onto the service table. Some device to hold the Tray Pack when it has been heated is necessary.

The generator was very loud causing some inconvenience to the customers and workers and would not be suitable within range of hostile forces. A quieter generator is needed.

The cover for the Tray Pack converter is one piece that must be removed and set aside to withdraw a Tray Pack. A hinged cover that can be partially opened, or a cover that slides to allow access to any quadrant to remove individual Tray Packs would make the process easier for the cooks.

IV. CONCLUSIONS AND RECOMMENDATIONS

There are three major conclusions which can be drawn from results of the field evaluation described in this report. First, the MFSU can be operated efficiently by two personnel and this was demonstrated.

The second major conclusion supported by the results is that the T-ration provides an acceptable meal in the field environment within the constraints of the limited menus used during the evaluation, the T-ration provided a more acceptable meal than did some usually highly popular A-ration items.

The third conclusion is that the prototypes used were reliable and did operate to expectations. However, further field use is required to confirm this aspect. The Mark 2 arrangement appears to be a better alternative than the Mark 3 layout insofar as time to heat is concerned.

Based upon these conclusions and the evaluation results, the following recommendations are made:

1. Tray Pack food items should be utilized in field exercise wherever practicable in order to develop more data on their suitability and acceptability and to acquaint field units with the products.

2. Further development of an MFSU prototype should be undertaken at NLABS to incorporate –

- a hinged or sliding lid for the Tray Pack heater (converter)
- a more efficient serving table configuration
- an improved Tray Pack holder to move hot Tray Packs
- a quieter generator

3. Further field evaluations of the prototype MFSU should be undertaken. Focus should be placed on alternative operational concepts so that total run times can be reduced and on equipment reliability/maintainability.

APPENDICES

APPENDIX A

COOK'S INFORMATION

The purpose of the Mobile Food Service Unit (MFSU) is to provide a hot T-ration to troops in forward locations. A T-ration is a meal served from half-size steam table pans. An individual pan will contain either the entree, vegetable, starch, or dessert. The pan needs only to be heated and opened to be served. The entree will serve 10 to 12 portions. The vegetable and starch pans will serve about 20 portions. The number of servings in the dessert will vary according to type.

The MFSU, in this case mounted on a trailer, will be loaded with Tray Packs at the bivouac area and the Tray Pack will be heated while traveling to the location where they will be served. At the serving location one cook will set up the serving table while the other removes the Tray Packs from the hot water container. The Tray Pack is opened, placed in an insulated serving container and served on disposable trays. The customers help themselves to beverages. When all customers are served, the serving table is put back on the trailer and new Tray Packs are placed in the hot water as required. The trailer is then hauled to the next location and the process is repeated. When all troops have been fed, the trailer returns to the bivouac area where it will be cleaned and the water drained.

APPENDIX B

CUSTOMER EVALUATION SCALES

NINE–POINT SCALE USED TO RATE FOOD ACCEPTABILITY

1 Dislike Extremely

2 Dislike Very Much

3 Dislike Moderately

4 Dislike Slightly

5 Neither Dislike Nor Like

6 Like Slightly

7 Like Moderately

8 Like Very Much

9 Like Extremely

SEVEN–POINT SCALES USED TO RATE ENTREE TEMPERATURE AND ENTREE PORTION SIZE

TEMPERATURE	PORTION SIZE
1 Much Too Cold	1 Much Too Small
2 Too Cold	2 Too Small
3 Slightly Too Cold	3 Slightly Too Small
4 Just Right	4 Just Right
5 Slightly Too Hot	5 Slightly Too Big
6 Too Hot	6 Too Big
7 Much Too Hot	7 Much Too Big

APPENDIX C

GUIDELINES FOR OBTAINING FOOD ACCEPTANCE RATINGS

1. Try as much as possible to remain neutral and receptive to the opinions of respondents. We want **their** opinions.

2. Approach people who are just finishing their meals so they will have tried each food item we want them to rate.

3. We cannot force people to answer our questions, so request participation by saying something like:
   "Hi. May I ask you some questions about your (lunch)?"

4. Explain the scale and request answers by saying something like "I have a scale here (hand the scale to the person) which goes from 1 for Dislike Extremely to 9 for Like Extremely. I need a number for each of the food you had for lunch. How was your (spaghetti)?"

5. Record a mark in the column corresponding to the rating number given. Watch out for answers like, "It was pretty good — I'll give it a 2," which might mean that the person used the scale backwards.

6. After you've gotten a rating for each food item, ask "How would you rate this meal?" Use the same 9-point scale.

7. Ask about the temperature and portion size of the entree by saying something like:
   "Now I'd like to ask you two questions about your (spaghetti). First about temperature: On this scale from 1 for Much Too Cold to 7 for Much Too Hot, how would you rate the **temperature** of your (spaghetti)? OK, now about the size of your serving of (spaghetti): On this scale from 1 for Much Too Small to 7 for Much Too Big, how would you rate the **size** of your portion of (spaghetti)?"

8. When collecting food acceptance data from a large number of people, try to ask one person at a table so that ratings will not be too influenced by responses of other people. Try to collect ratings from at least 30 people at each meal and location. In locations where fewer than 30 people are eating, try to collect ratings from all, but try to indicate that individual opinions are desired.

APPENDIX D

DATA COLLECTION SHEETS

FORWARD LOCATION DATA

_____
Date

_____
Collector

	Clocktime	Elapsed Minutes
Departure	_____	_____
Arrive Location No. _____	_____	_____
Begin Serving	_____	_____

_____/_____
Begin End

_____/_____

_____/_____

_____/_____

_____/_____

_____/_____

		Begin	End
Begin Pack Up	_____	_____	
Departure	_____	_____	

	Begin	End
Trailer Water _____	_____	_____
Serving Water _____	_____	_____
_____ Entree	_____	_____
_____ Starch	_____	_____
_____ Vegetable	_____	_____
_____ Dessert	_____	_____

T-Ration Used		Disposable Trays	
Entree	_____	No. Begin	_____
Starch	_____	No. End	_____
Vegetable	_____	Used	_____
Dessert	_____		

NOTE: Use Reverse for pertinent comments, e.g., delays, leaks, refuel, etc.

BASE CAMP DATA

_____ Date

_____ Collector

		Begin	End
Trailer Water	Time	_____	_____
	Temp	_____	_____
Serving Water	Time	_____	_____
	Temp	_____	_____
_____ Entree	Time	_____	_____
	Temp	_____	_____
_____ Starch	Time	_____	_____
	Temp	_____	_____
_____ Vegetable	Time	_____	_____
	Temp	_____	_____
_____ Dessert	Time	_____	_____
	Temp	_____	_____

T–RATIONS USED

	Number
Entree	_____
Starch	_____
Vegetable	_____
Dessert	_____

DISPOSABLE TRAYS USED

No. Beginning	_____
No. Ending	_____
No. Used	_____

APPENDIX E

SUMMARY OF THE ANALYSIS OF VARIANCE ON CUSTOMER EVALUATION RATINGS

An analysis of variance was performed to determine whether the observed differences between average evaluations of T and A-rations and MCI meals were statistically significant, and thus real differences, in the sense that the same patterns could be expected if the experiment were repeated under the same circumstances. Three variables were selected for the statistical analysis: overall meal, temperature, and portion size evaluations. Evaluations of entrees, starches, and desserts were excluded from the statistical analysis since the information obtained would be redundant (for example, overall ratings correlate highly with entree and dessert evaluations) and to reduce the experiment-wide error probability.

Following the analysis of variance, the Newman-Keuls procedure was utilized to determine which means were significantly different from which other means within the pertinent ANOVA summary, for example, overall meal evaluations. The Newman-Keuls procedure is a post-hoc comparison technique and was chosen in this case since we had no preconceived hypotheses, such as, that T-rations would be evaluated more favorably than A-rations.

ANALYSIS OF VARIANCE – MEAL TEMPERATURE

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	3	0.5420	0.2710	0.377	0.6860
Within Groups	233	167.2673	0.7179		
Total	235	167.8093			

Group	No.	N.	Mean	95% Confidence Level
A-Ration Supper	1	92	3.6	3.4790 to 3.8906
T-Ration-Forward	3	76	3.6	3.4758 to 3.8663
T-Ration Base Camp	4	68	3.5	3.4328 to 3.7142

Multiple Range Test – Student – Newman-Keuls Procedure

Ranges for the 0.05 Level: 2.81 3.34

Homogeneous Subsets

Subset 1

Group	04	03	01
Mean	3.5735	3.6711	3.6848

ANALYSIS OF VARIANCE — MEAL ACCEPTABILITY RATINGS

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	3	203.0209	67.6737	21.691	0.0000
Within Groups	359	1120.0588	3.1199		
Total	362	1323.0797			

Group	No.	N.	Mean	95% Confidence Level
A-Ration Supper	1	116	6.2	5.8811 to 6.5672
MCI-Lunch	2	101	5.4	4.9964 to 5.8155
T-Ration Forward	3	78	7.2	6.9163 to 7.5190
T-Ration Base Camp	4	68	7.2	6.8704 to 7.6002

Multiple Range Test — Student — Newman-Keuls Procedure

Ranges for the 0.05 Level: 2.81 3.34 3.66

Homogeneous Subsets

Subset 1

Group	02
Mean	5.4059

Subset 2

Group	01
Mean	6.2241

Subset 3

Group	03	04
Mean	7.2179	7.2352

ANALYSIS OF VARIANCE – PORTION SIZE

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob
Between Groups	3	15.3002	5.1001	4.278	0.0056
Within Groups	300	375.6340	1.1921		
Total	303	372.9342			

Group	No.	N.	Mean	95% Confidence Level
A-Ration Supper	1	96	2.9	2.7048 to 3.1910
MCI-Lunch	2	65	2.5	2.2379 to 2.8390
T-Ration Forward	3	75	3.0	2.8385 to 3.3215
T-Ration Base Camp	4	68	3.1	2.9629 to 3.3606

Multiple Range Test – Student – Newman-Keuls Procedure

Ranges for the 0.05 Level: 2.81 3.34 3.66

Homogeneous Subsets

Subset 1

Group	02
Mean	2.5385

Subset 2

Group	01	03	04
Mean	2.9479	3.0800	3.1618

DISTRIBUTION LIST

	Copies
Defense Technical Information Center	12
Defense Logistics Study Information Exchange	2
US Marine Corps	
Code RDS	1
Code LFS–4	2
Code LME	4
Code DO–7	2
US Navy	
Navy Food Service Systems Office	3
National Naval Medical Center	1
Naval Research Laboratory	1
US Army	
Deputy Chief of Staff for Research, Development and Acquisition (DAMA–CSS–D)	1
Deputy Chief of Staff for Logistics (DALO–TST)	1
(DALO–TST–F)	2
Troop Support Agency (DALO–TAF)	1
(DALO–TAD)	3
Quartermaster School	1
Office of the Surgeon General	2
Logistics Assistance Office, FORSCOM	12
Engineer School	1
Defense Logistics Studies Information Exchange	2
Logistics Management Center	2
Test and Evaluation Command	1
Aberdeen Proving Ground	1
Cold Regions Test Center	1
Electronic Proving Ground	1
Aviation Development Test Activity	1
Dugway Proving Ground	1
Tropic Test Center	1
White Sands Missile Range	1
Yuma Proving Ground	1
Jefferson Proving Ground	1
Army Research Office	2
26th Infantry Division, Boston	1
Massachusetts Army National Guard, Boston	1
Letterman Army Institute of Research	2
39th Engineering Battalion, Fort Devens	2

	Copies
US Air Force	
Engineering and Services Center	1
USAF/LEEES	1
USAF/LEEHC	1
Logistics Command	1
AFMSC/SGB	1
AUL/LSE	1
Other	
OASD(MRA&L)	1
Under Secretary of Defense for Research and Engineering	1
HQ, AMD–RDX	1
USAAHS (ATSA–CD–A)	1
USAAHS (HSA–CDM)	1
University of Wisconsin	1
USDA–SEA US Department of Agriculture (SEA)	1
L.J. Minor Corporation	1
University of Nevada	1
University of Massachusetts	1
ARA Services, Inc.	1
NC Department of Correction	1
Cornell University	1
American Hospital Association	1
Defense Personnel Support Center	5
Internal Distribution	
Technical Director	
Deputy Technical Director, Clothing and Equipment Systems Program	1
Deputy Technical Director, Food Service System Program	1
Commander, US Army Research Institute for Environmental Medicine	1
Special Assistant for DoD Food Program	2
Director, Aero-Mechanical Engineering Laboratory	1
Director, Individual Protection Laboratory	1
Director, Food Engineering Laboratory	3
Director, Science and Advanced Technology Laboratory	3
Joint Technical Staff, DoD Food RDT&Eng Program	10
US Air Force Liaison Officer	3
Chief, Technical Library	2
Chief, Engineering Programs Management Office	2
Chief, Operations Research and Systems Analysis Office	20
Chief, Behavioral Sciences Division (SATL)	2
RDT&Eng Advisor, Food Service Facility and Equipment Planning Board, Food Engineering Laboratory	1